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# SENGENUITY TempTrackr™ System/Kit

# SENGENUITY TempTrackr™ Wireless Reader

# *User Operating Instructions & Manual*

| Issue | Date | Description of Changes | Approval |
|---|---|---|---|
| 1.0 | 6/14/2010 | Initial release | RJA/SS/MB/JA |
| 2.0 | 7/9/2010 | Revised End-user Software by VI-NBH; RS232 instead of CAN | MB/SS/JA |

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The Wireless TempTrackr System and Wireless Reader from Vectron International are advanced measurement and sensor solutions intended for a broad range of industrial application where monitoring of temperature is a critical requirement. This Vectron product allows remote sensing and monitoring of temperatures using passive SAW sensors and wireless technology in many types of user applications.

Please follow all user instructions and safety precautions as described in this manual for proper and safe operation of the equipment. In particular many countries have established regulations for the Electro Magnetic Compatibility (EMC) of equipment that can emit Electromagnetic radiation that can affect other equipment or be sensitive to other sources in the vicinity during use. When the product that you have purchased is tested and labeled to demonstrate compliance to such regulations it is important that users operate the equipment to ensure compliance and any attempt to alter, tamper, or reverse-engineer the equipment, both hardware and/or software may render the product warranty null and void and render the equipment non-compliant to country EMC standards. See Safety warnings/precautions later in this manual.

## INITITAL ASSEMBLY OF THE EQUIPMENT

Depending on the configurations you may have ordered, the product may be a "kit" fully configured, turn-key system or only the wireless reader (WST type).

- Ensure that the shipped product conforms to your order. Notify the factory if any item is missing.
- Ensure that the items received are in good conditions. Report damage to the factory immediately for replacement or repair per the terms of warranty.

## INSTALLATION & TURNING THE SYSTEM ON

- Hook-up the reader with the proper cable/connector to the computer and to the power supply

***Caution: Electronic component can be sensitive to Electro Static Discharge (ESD) events. The use of proper personnel grounding is highly recommended. Failure of the product to operate properly and due to a user-induced ESD-related event is not covered by Vectron's warranty***

- Attach the antenna to the reader
- Place the sensor element where the temperature is to be monitored
- Load the software on the computer.

  ***Note: Depending on the configuration ordered the software access will be limited and certain operational settings are not adjustable by the user.***

- Turn on the system. Refer to the software installation and operation section in this manual.

## 2. Operations: General Principles of SAW Temperature Sensor

SAW-based temperature sensing involves electrically inducing an acoustic wave into a piezoelectric material and then reconverting the energy of the wave (influenced by the temperature to which the sensing element is exposed) back into an electrical signal for temperature measurement. One significant advantage of SAW devices is their passive operation, which makes them very amenable to operation in harsh environments via wireless interrogation. Passive, wireless, SAW-based sensing systems have been described in many publications and some systems are now being offered. Some of the available systems utilize SAW resonators and some are SAW delay line based. The interrogation techniques sometimes can include coding schemes. Possibly the simplest and lowest cost techniques use uncoded resonators at multiple frequencies. This limits the number of unique identifiers available, but this can prove sufficient for certain applications, a few of which are discussed in this paper. With any wireless system design, the ambient RF noise environment must be understood and addressed. Each application area presents challenges requiring engineering support for mounting structures and methods, packaging, antenna design, etc., along with local regulations (e.g. FCC, CE, or UL) regarding emissions and safety requirements in hazardous environments. In the systems described herein, enclosures surrounding the SAW sensors may be well-shielded, allowing resonator frequencies that are outside of regulated frequency bands. The SenGenuity system operates from approximately 428 MHz to 439 MHz.

In these types of applications, SAW-based passive wireless temperature sensing technology offers distinct advantages over these traditional measurement methods, including

- Passive operation, since SAW-based temperature sensors require no batteries or external power-supply. The resulting advantages over actively powered sensing solutions include:
  - Low environmental foot print as passive SAW temperature sensors avoid the adverse environmental impact of batteries.
  - Logistical advantage: The burden of regularly needing to monitor remaining battery life and replace them is eliminated.
- Electrically non-invasive solution: by not requiring wires to power/read sensors, a SAW-based temperature measurement solution can provide an electrically non-invasive solution for high power equipment such as switchgear and other Smart Grid applications.
- Wireless interrogation: SAW-based temperature sensors can be read wirelessly. This makes them well suited for rotating applications and for those applications where sensors are placed in difficult to reach or isolated locations.

The SenGenuity wireless SAW resonator (SAWR) based temperature sensing solution consists of a reader (RF Transceiver) RF or capacitively linked to one or more SAWR sensing elements as depicted in Figure 1. The system operates in a range from 428 MHz to 439 MHz.

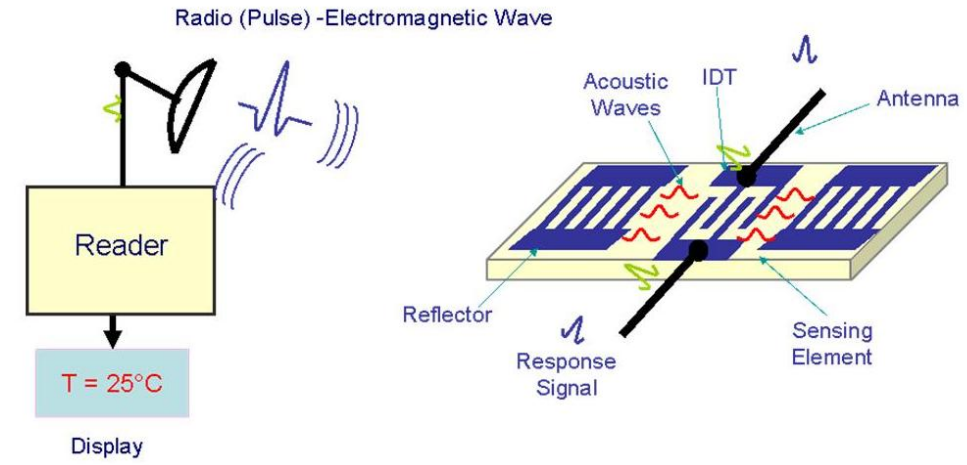



Figure 1: Wireless SAW Temperature Sensing System

Wireless sensors based on changes in resonant frequency require an appropriate reader. TempTrackr reader is base on "time domain" approach which is typically employs double heterodyne down-conversion with in-phase and quadrature sample streams at base-band. Direct down-conversion and single heterodyne conversion are possible although the susceptibility to possible out-of-band spurious signals is worse. Discrete Fourier Transform (DFT) analysis of the in-phase and quadrature samples to obtain power spectral density (PSD) and curve fit interpolation of the PSD values is employed. While these extra steps incur additional electronics complexity and computational burden, they overcome the limitations of the purely "frequency domain" method. The spacing of the interrogation frequencies is primarily limited by the bandwidth of the resonator response of the sensor and the bandwidth of the pulse's power spectral density. Saturation of the receiver is desired in the time domain samples since frequency information is not lost through saturation. The effects of saturation in frequency domain and time domain readers is analogous to the same effect in amplitude modulated (AM) versus frequency modulated (FM) radio receivers.

In the time domain, saturation tends to make the ring-down of the resonator appear longer and more uniform, resulting in better apparent accuracy, as seen in Figure 3. The degree of saturation should still be somewhat limited to prevent deterioration of the spurious signal rejection ratio.

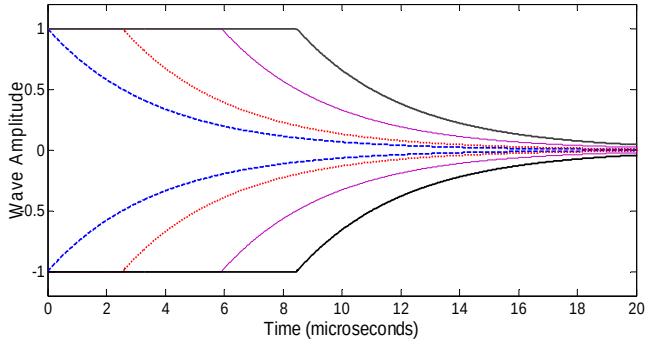



Figure 3. The decay envelope is shown for a resonator with a Q of 10,000. The blue lines indicate the received signal with no saturation. Red, purple and black indicate 2x, 5x, and 10x amplitude saturation resulting in 2.5, 6, and 8.5 μs of apparent increase in the decay time of the digitized waveform.

The Q of the SAW resonator is a critical parameter, both as the unloaded Q and as the loaded Q determined by the radiation resistance and loss resistances of the antenna. Figure 4 illustrates that the resonator, with an unloaded Q of nearly 12,000, requires a loaded Q of at least 6,000 for high received signal strengths. A low-Q resonator of similar design is also shown with an unloaded Q of approximately 7,500. The diminished pulse width is seen to reduce the received power by 3 dB. These values of Q are

readily achievable with SAW resonators.

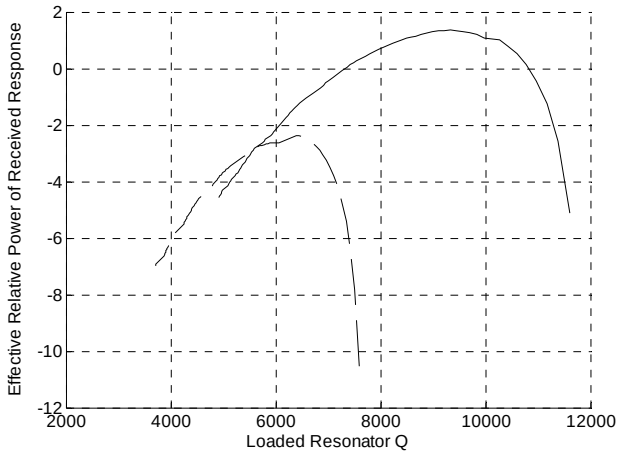



Figure 4. A SAW response with high Q (TFSS432, solid) is analyzed assuming a 1μs switching time between interrogation pulse and receiving and a 22 μs receive gate time. The roll-off at very high loaded Q's result because the wave is not sufficiently reradiated by the antenna. The roll-off at low

Figure 5. Interrogation unit (reader) and three typical SAW temperature sensor modules. The sensor elements are 3.8mm x 3.8mm ceramic-packaged resonators embedded in the PCB package. The coil antenna shown has been designed for operation in the vicinity of 433 MHz with a desirable radiation pattern.

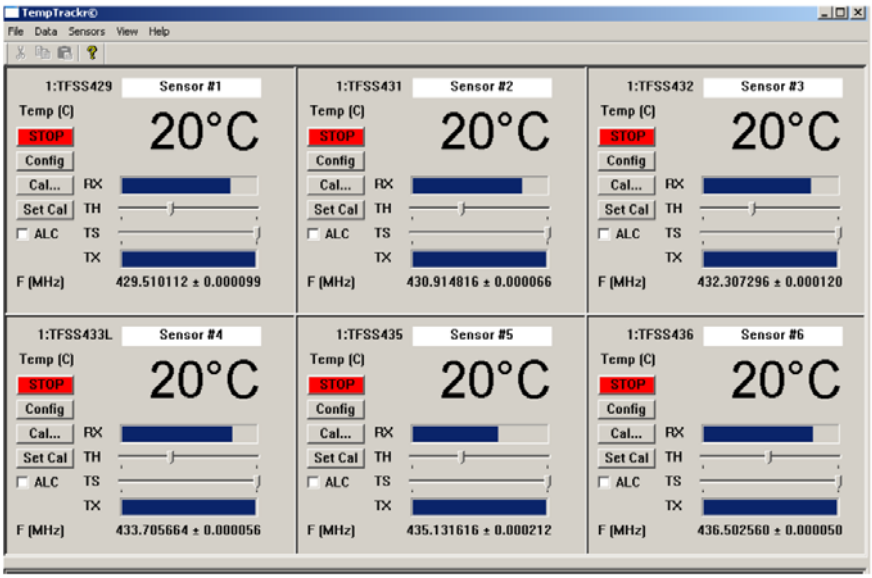



Figure6. In standalone applications, the temperatures can be displayed as shown on this PC screen image. Typical installations embed the reader electronics into the overall system monitoring electronics.

## *3. Software Installation & Operation*

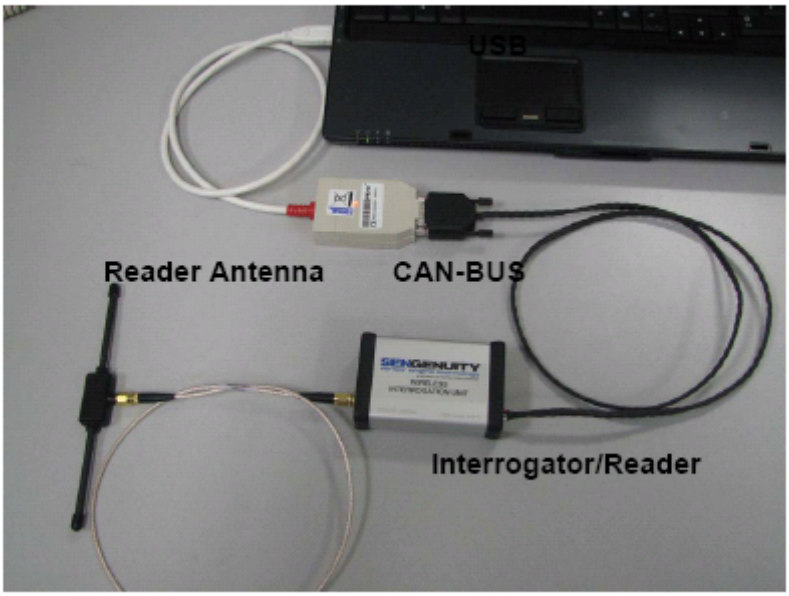
*(Note: This section may nit apply if users do not purchase the software and/or have no access to the installed software)*

This section describes the following:

- **TempTrackr© - PC Software**
  - Install the CAN bus and the TempTrackr program
  - Run the software
  - Program features
- **Sensor deploy and Installation steps**
  - Reader and Sensor antennas
  - Critical distances and metal wall reflections
  - Spurious modes

- **Reader and USB-CAN-BUS**

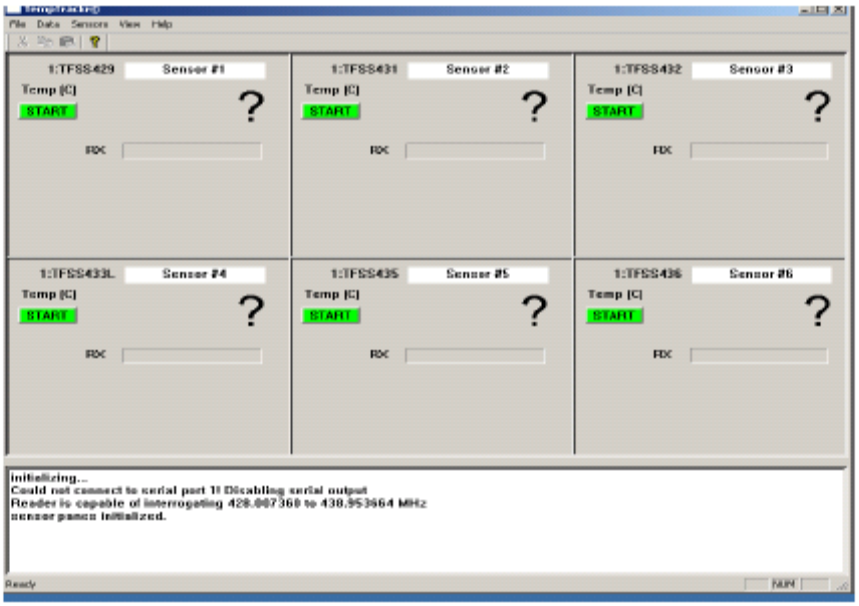
**Step 1:** Install the CAN-bus driver and TempTrackr program
**Step 2:** Connect the USB into the PC/Laptop




**CAN:**
**C**ontroller **A**rea
**N**etwork

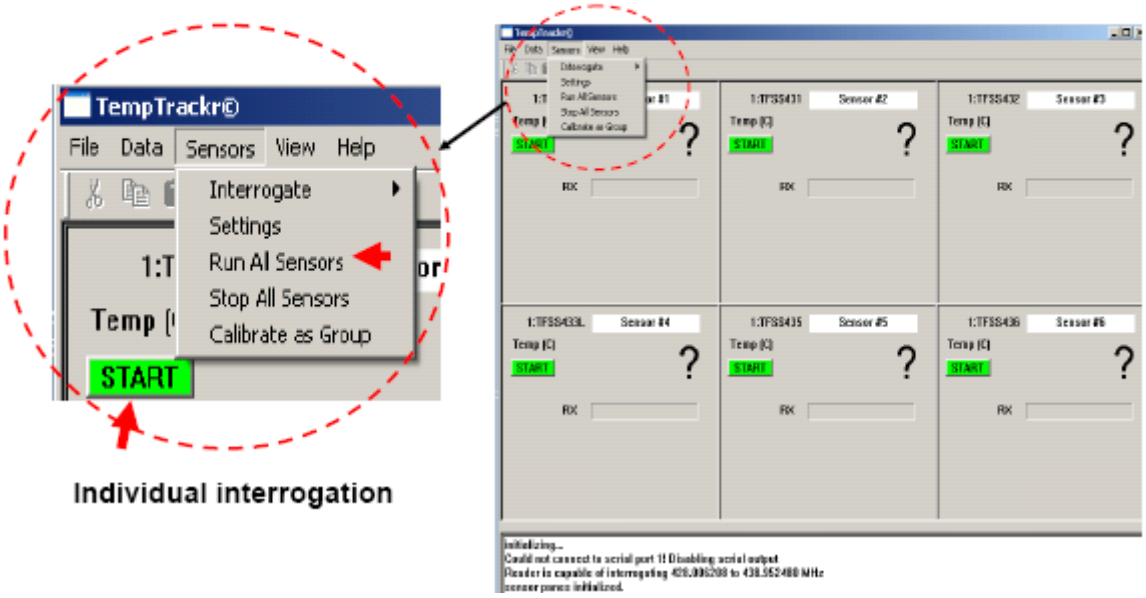
- **Temperature Sensor Software**

**Step 3: Run the program:**
*- Please wait few second after the USB is connected into the PC/Laptop and the red light flash/blink*
*- By* double click on ***TempTrackr.exe*** the following GUI window pop up

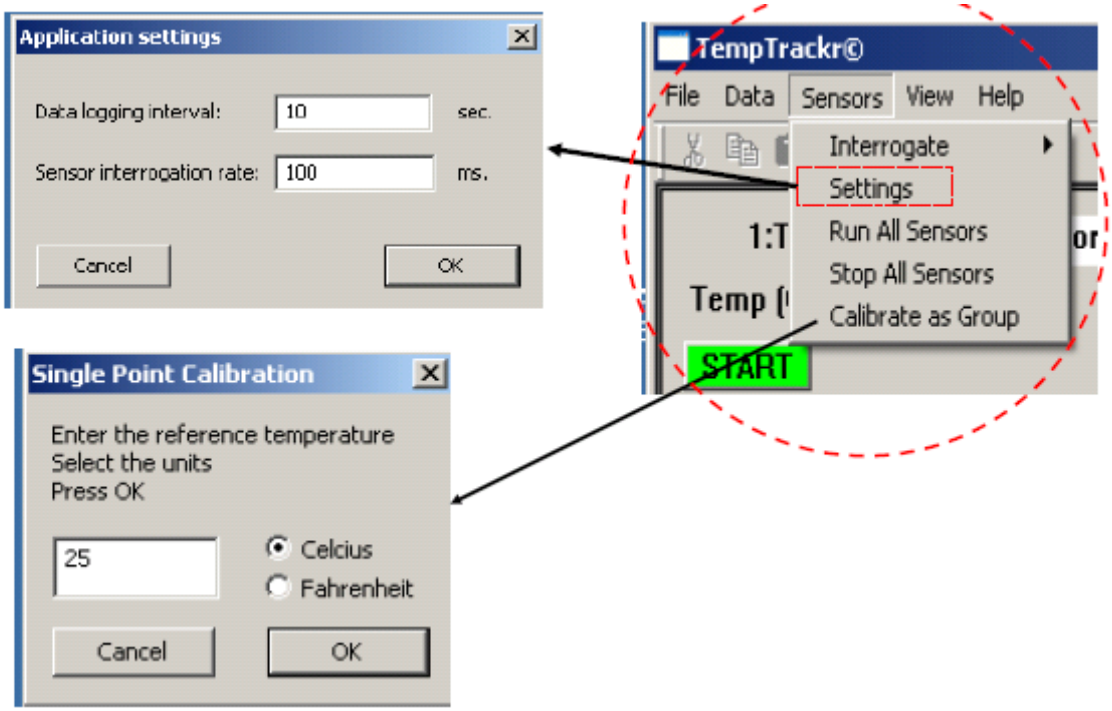


- **Run the Interrogation**

**Step 4: Run the interrogation:**
*By* double click on *TempTrackr.exe* the following GUI window pop up:
*Run All Sensors:*
- Push the Sensors button and select "Run All Sensors" to interrogate all sensors at the same time
- Press the START button only to run individual sensors.

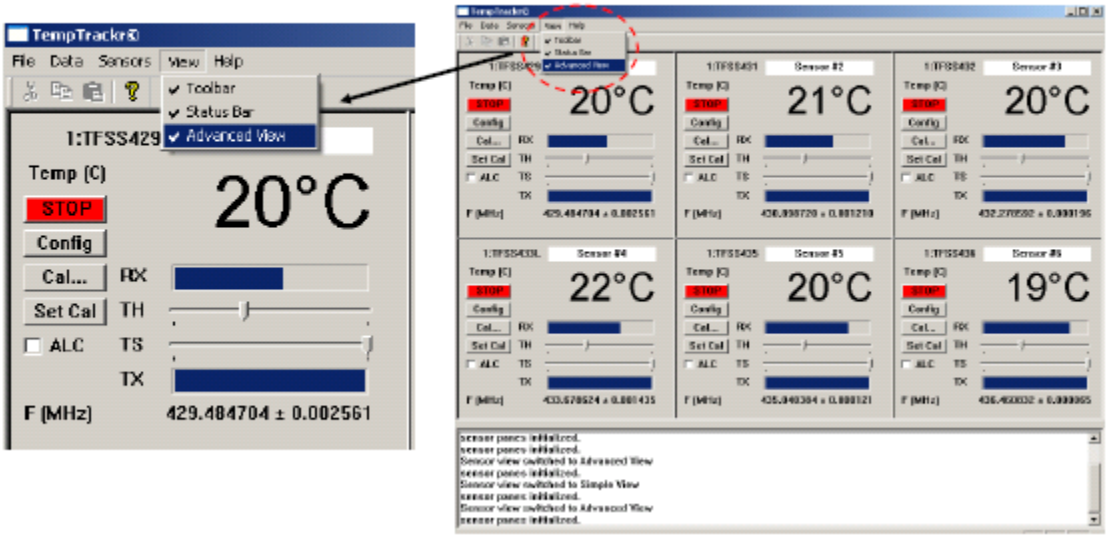



- **TempTrackr Application Settings & Calibration:**



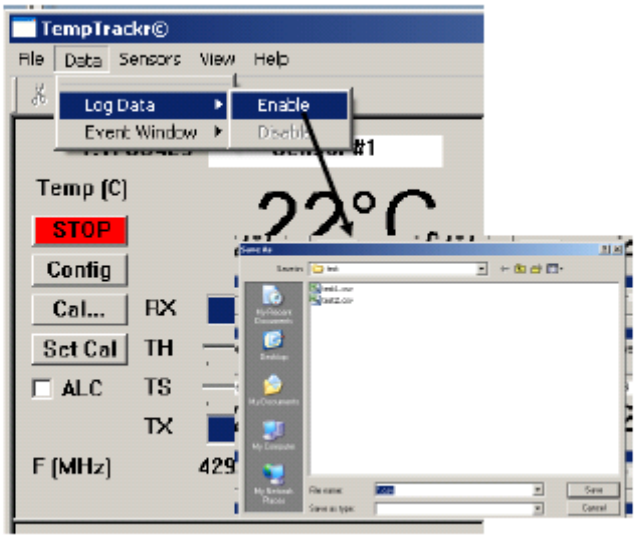
- **Advanced View**

**Advanced View:** *TH, TS, TX and the sensor frequency*

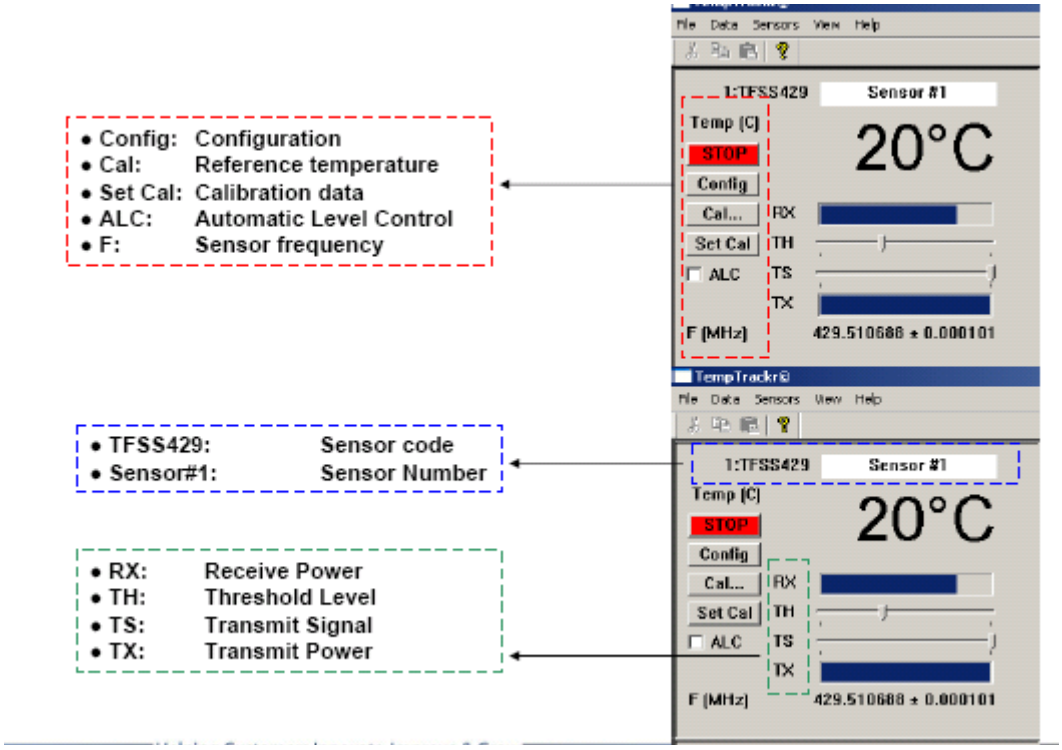


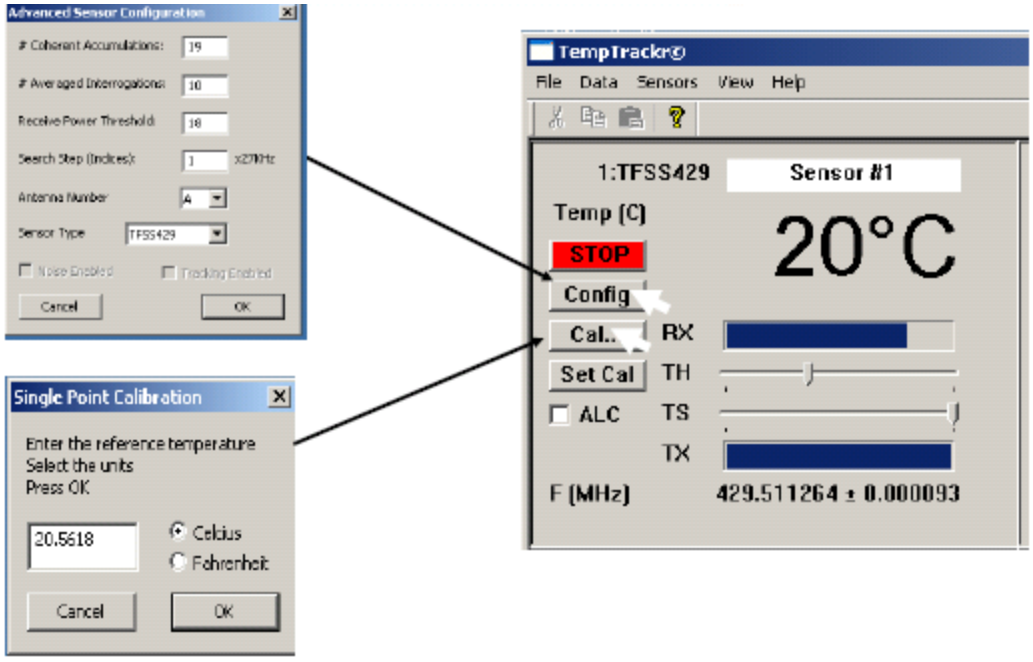

- **Log Data**

**Log Data:**
*Save the interrogation data into file*

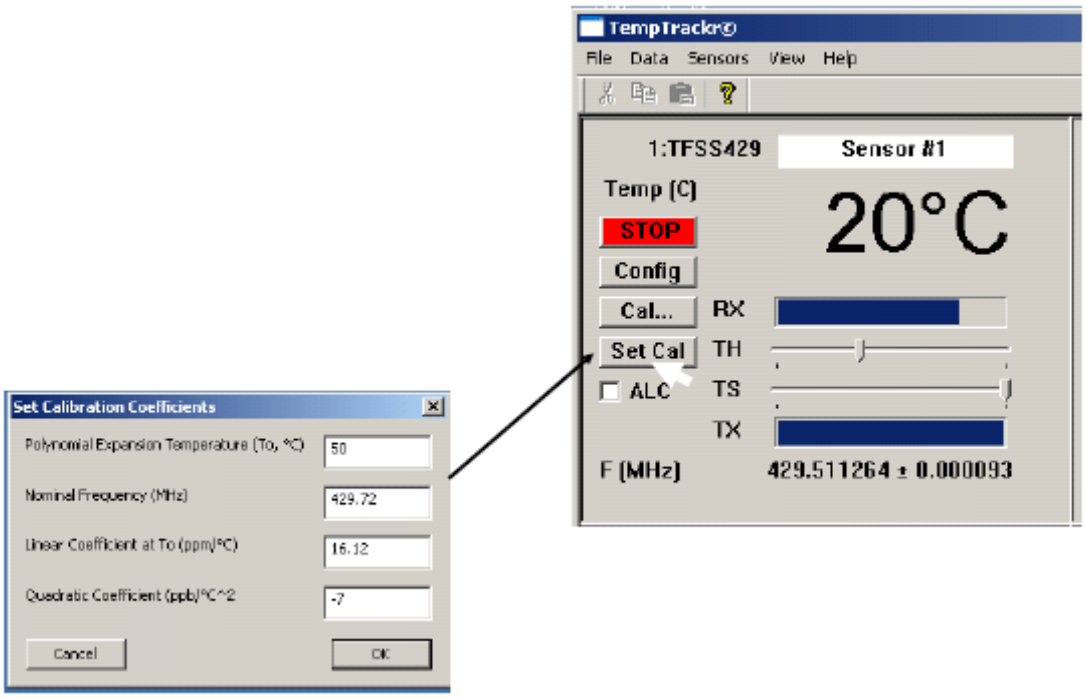


- **TempTrackr Program Features**

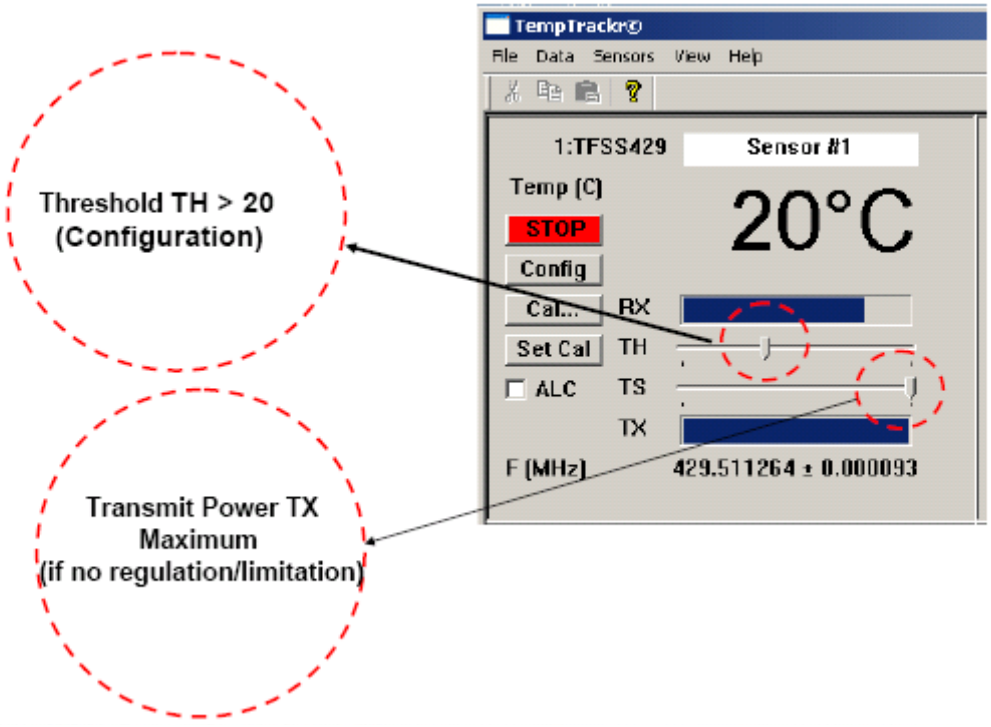


- **TempTrackr Program Features**

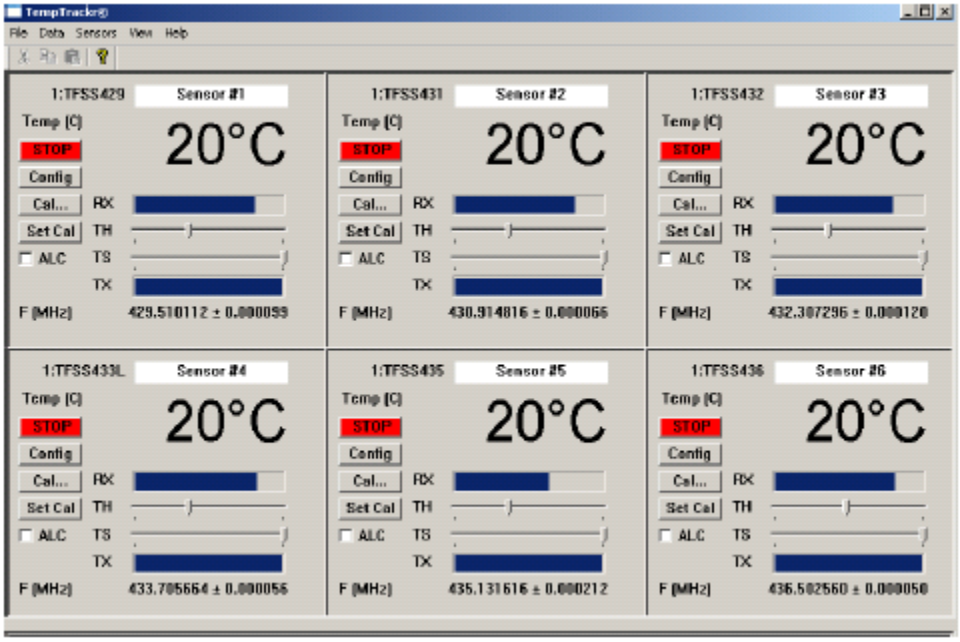



- **Receive Power (RX)**



- **TempTrackr Screen Display**

TempTrackr



## *4. Operations: Safety Precautions*

In compliance to Agency certification and requirements for operating safety warning instructions, Vectron International is providing the following information for the safe operation of the Wireless Temp Tracker system and Wireless Reader. This information applies to all models/configurations of the system (Models TempTrackr-03, -06, -09) and stand-alone Wireless readers (Model WSR-T2), used either as Vectron-furnished turn-key system or when integrated into users' equipment.

The Temp tracker as a system or key individual components have been certified for EMC compatibility using various national/country certification directives and standards, and will be affixed with an appropriate certification ID (e.g. FCC, IC ID, CE marking etc.)[1]. These certifications apply only with a certain operating configuration of the device (e.g. transmit power level, duty cycle etc.) in order to comply with the associated functional requirements for compliance. For a compliant product, which is so labeled, the configuration will be fixed as required (e.g. through user software) at the time of shipment when customers are ordering a compliant product so-labeled.

**USERS ARE CAUTIONED THAT ANY ATTEMPT TO ALTER THE PRODUCT CONFIGURATION EITHER THROUGH HARDWARE OR SOFTWARE MODIFICATION WILL RENDER THE PRODUCT NON-COMPLIANT AND WILL VOID VECTRON'S WARRANTY PROVISIONS IN THE TERMS & CONDITIONS OF SALE.**

## CAUTION

**(Statements legally required under country laws or certification agencies)**

**U.S. Federal Communication Commission Interference Statement**

[1] The TempTrackr system has been tested to meet various U.S. and International EMC RF radiation/emissions compliance requirements (U.S. FCC, Canadian, European standards). Registered ID's may vary by product model but generally appear on the product labels as:
**FCC ID X3ITEMPTRACKR**
**IC: 8085B-TEMPTRACKR**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

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## Industry Canada Compliance

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This device has been designed to operate with antennas having a maximum gain of XdBi. Antennas having a gain greater than XdBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

## RF Exposure Statements

For MOBILE devices subject to RF Exposure concerns: (e.g., 15.247 devices)

**WARNING!**
**FCC and IC Radiation Exposure Statement:**
This equipment complies with FCC's and IC's RF radiation exposure limits set forth for an uncontrolled environment under the following conditions:

1. This equipment should be installed and operated such that a minimum separation distance of 20cm is maintained between the radiator (antenna) & user's/nearby person's body at all times.
2. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter."

For PORTABLE devices where Specific Absorption Rate (SAR) testing is applicable:

**WARNING!**
**FCC and IC Radiation Exposure Statement:**
This portable equipment with its antenna complies with FCC's and IC's RF radiation exposure limits set forth for an uncontrolled environment. This equipment has shown compliance with FCC's and IC's Specific Absorption Rate (SAR) limits. To maintain compliance follow the instructions below:

1. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

**The following may or may not apply to portable devices with SAR results. Applicable statements will probably be different from device to device and may need to be examined on a case by case basis.**

2. {If equipment is supplied with accessories, (e.g., belt clip for body worn operation) then a warning should be included to restrict the use of the device only to the accessories tested during SAR evaluation. Accessories with metal components should not be used with the device, unless specifically tested.}"

For PORTABLE devices where SAR in NOT applicable: (power[mW] < 60/f[Ghz])

**WARNING!**
**FCC and IC Radiation Exposure Statement:**
This portable equipment with its antenna complies with FCC's and IC's RF radiation exposure limits set forth for an uncontrolled environment. To maintain compliance follow the instructions below:

1. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. Avoid direct contact to the antenna, or keep contact to a minimum while using this equipment."

For MODULAR devices subject to RF Exposure concerns:

**"This transmitter module is authorized to be used in other devices only by OEM integrators under the following conditions:**

1. The antenna(s) must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) & user's/nearby person's body at all times.

2. The transmitter module must not be co-located with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing the end-product for any additional compliance requirements with this module installed. (i.e., digital device emissions, PC peripheral requirements, etc.)

**IMPORTANT NOTE:** In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC / IC authorization is no longer considered valid and the FCC ID / IC number cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC / IC authorization.

The OEM integrator must be made aware not to provide information to the end user regarding how to install or remove this RF module in the user manual of the end product.

The user manual for the end product must include the following information in a prominent location:

"To comply with FCC's and IC's RF radiation exposure requirements, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) & user's/nearby person's body at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.""

## CE Marking & Compliance:

To be compliant to the EU directive 2004/108/EC for EMC for Short Range Radio Frequency devices, the Temp Tracker system or the Wireless reader is configured as required (e.g. through user software) to operate only within the unlicensed 433MHz ISM band (frequency range 433,05MHz to 434,79 MHz) (433MHz ISM band). Therefore when the shipped product is labeled with CE marking, users must operate the product only within this permissible frequency band at the permissible power level allowed by the regulations.
Customers are advised that any modification or operation of the reader that is CE- marked outside of the permitted frequency band and power level limits will render the product non-compliant to those standards. Customers are solely responsible for certification of their end-product to the applicable country standards should the CE-marked reader sold by Vectron be integrated into the end-product sold by customers and the reader is modified or operated outside of the original CE certification limits. Vectron assumes no liability for operation of any CE-marked reader in any manner inconsistent with the requirement of the applicable standards.

Any use outside the ISM band/frequency should be reviewed by customers and certified in the EU country by country.